

AMENDMENTS TO CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-82. (Canceled)

83. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 82 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis; and

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by grating structures arranged in an in-axis form along the amplifier axis, and the gain clamping efficiencies of the grating structures declining from the input facet to the output facet,

wherein the more the grating structures approach the output facet, the larger the magnitude of structure discontinuity of the grating structures is, ~~thereby realizing the declining effect of the gain clamping efficiencies of the grating structures and~~

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal.

84. (Previously Presented) The optical amplifier as claimed in Claim 83, wherein said structure discontinuity of the grating structures is realized by the index difference of the grating structures.

85. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 82 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis; and

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by grating structures arranged in an in-axis form along the amplifier axis, and the gain clamping efficiencies of the grating structures declining from the input facet to the output facet,

wherein the more the grating structures approach the output facet, the more the oscillation wavelength of the grating structures matches the peak of the spectrum of the gain medium, thereby realizing declining effect of the gain clamping efficiencies of the grating structures
~~thereby realizing the declining effect of the gain clamping efficiencies of the grating structures~~
and

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal.

86. (Previously Presented) The optical amplifier as claimed in Claim 85, wherein the matching of the oscillation wavelength of the grating structures and the peak of the spectrum of the gain medium is realized by said grating structures disposed with varying pitches.

87-89. (Canceled)

90. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 89 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis;

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by laser cavities, each of the laser cavities being defined by a pair of mirrors disposed beside the gain medium, said mirrors facing each other and arranged in an off-axis form along the amplifier axis;

wing structures disposed between each of said mirrors and the gain medium, respectively, wherein the optical gain coefficient of the wing structures increases from the input facet to the output facet, thereby making the clamped local carrier densities of the gain medium of the optical amplifier decline to satisfy the round trip condition of the corresponding laser cavities; and

further comprising a series of longer laser cavities with wing structures inserted thereinto to realizing the declining effect of the local carrier densities, and a series of shorter laser cavities containing no wing structures, to determine the carrier response time,

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal.

91. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 87 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis; and

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by laser cavities, each of the laser cavities being defined by a pair of mirrors disposed beside the gain medium, said mirrors facing each other and arranged in an off-axis form along the amplifier axis; and

further comprising photon detectors for receiving output optical powers from said gain clamping laser cavities, wherein the photon currents output by the photon detectors indicate

signal power levels at the portions of the gain medium corresponding to said gain clamping laser cavities,

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal.

92. (Previously Presented) The optical amplifier as claimed in Claim 91, further comprising amplifiers to amplify the optical powers from said gain clamping laser cavities and transmit the amplified optical powers to said photon detectors.

93. (Previously Presented) The optical amplifier as claimed in Claim 91, wherein the photon currents of the photon detectors are used to control the gain coefficient distribution of the optical amplifier.

94. (Previously Presented) The optical amplifier as claimed in Claim 91, further comprising wing structures inserted into the laser cavities, wherein the photon currents are used to control the gain coefficients of the wing structures, thereby making the photon currents control the distribution of the gain clamped carrier density of the optical amplifier.

95. (Previously Presented) The optical amplifier as claimed in Claim 92 or 93, wherein said optical amplifier is used as an optical signal equalizer to provide constant output power independent of input signal power level.

96. (Previously Presented) The optical amplifier as claimed in Claim 85, wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:
a slab waveguide region sandwiching said gain medium, said grating structure placed close to said slab waveguide region for defining in-axis laser cavities;

electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and
a wafer base for supporting the respective components,
wherein the grating structure is constructed so that the local resonate frequencies of the gratings gradually approach the peak frequency of the gain medium toward the output facet.

97. (Previously Presented) The optical amplifier as claimed in Claim 96, wherein the waveguide is straight, and the grating pitches of the grating structure vary.

98. (Previously Presented) The optical amplifier as claimed in Claim 96, wherein the varying grating pitches are realized by arranging the waveguide with curved profile.

99. (Previously Presented) The optical amplifier as claimed in Claim 83, wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:
a slab waveguide region sandwiching said gain medium, said grating structure placed close to said slab waveguide region for defining in-axis laser cavities;
electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and
a wafer base for supporting the respective components,
wherein the magnitude of discontinuity of the grating structure is constructed so that the more the grating structure approaches the output facet, the larger the magnitude of discontinuity of the grating structure is.

100. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 82 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:
a gain medium defining an amplifier axis; and
a plurality of gain claspers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain claspers being

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constructed by grating structures arranged in an in-axis form along the amplifier axis, and the gain clamping efficiencies of the grating structures declining from the input facet to the output facet,

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal, and

wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:

a slab waveguide region sandwiching said gain medium, said grating structure placed close to said slab waveguide region for defining in-axis laser cavities;

electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and

a wafer base for supporting the respective components,

wherein the grating pitches of the grating structure are uniform, and the grating structure is getting closer to the slab waveguide region toward the output facet.

101. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 88 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis; and

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by laser cavities, each of the laser cavities being defined by a pair of mirrors disposed beside the gain medium, said mirrors facing each other and arranged in an off-axis form along the amplifier axis, and wherein the products of reflectivities of the peak wavelength of the amplifier gain spectrum of the mirror pairs of the gain clamping laser cavities increase toward the output facet, thereby making the gain clamping efficiencies of the laser cavities decline from the input facet to the output facet,

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal, and

wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:

a slab waveguide region sandwiching said gain medium;

distributed Bragg reflector (DBR) regions disposed beside the slab waveguide region for acting as mirrors to define off-axis surface emission laser cavities;

electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and

a wafer base for supporting the respective components,

wherein at least one DBR region has a thickness varying along the waveguide region, and the DBR mirrors are constructed so that the local resonate frequency of the DBR mirrors gradually approaches to the peak frequency of the gain medium toward the output facet.

102. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 88 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis; and

a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by laser cavities, each of the laser cavities being defined by a pair of mirrors disposed beside the gain medium, said mirrors facing each other and arranged in an off-axis form along the amplifier axis, and wherein the products of reflectivities of the peak wavelength of the amplifier gain spectrum of the mirror pairs of the gain clamping laser cavities increase toward the output facet, thereby making the gain clamping efficiencies of the laser cavities decline from the input facet to the output facet,

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wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal, and

wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:

a gain medium having input and output facets;
a slab waveguide region sandwiching said gain medium;
distributed Bragg reflector (DBR) regions disposed as pairs beside the slab waveguide region for acting as mirrors to define off-axis surface emission laser cavities;
electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and
a wafer base for supporting the respective components,
wherein the DBR mirror pairs are constructed so that the products of reflectivity of the DBR mirror pairs decline from the input facet to the output facet.

103. (Previously Presented) The semiconductor optical amplifier as claimed in Claim 102, wherein at least one DBR region has the number of the DBR layers varying along the waveguide region.

104. (Currently Amended) ~~The~~ An optical amplifier as claimed in Claim 89 for amplifying optical signals, said optical amplifier having an input facet and an output facet, said optical amplifier comprising:

a gain medium defining an amplifier axis;
a plurality of gain clampers disposed along the amplifier axis to control the local carrier density distribution of the gain medium of the optical amplifier, each of said gain clampers being constructed by laser cavities, each of the laser cavities being defined by a pair of mirrors disposed beside the gain medium, said mirrors facing each other and arranged in an off-axis form along the amplifier axis; and

wing structures disposed between each of said mirrors and the gain medium, respectively, wherein the optical gain coefficient of the wing structures increases from the input facet to the output facet, thereby making the clamped local carrier densities of the gain medium of the optical amplifier decline to satisfy the round trip condition of the corresponding laser cavities,

wherein the whole carrier density distribution of the optical amplifier is controlled by the gain clampers, the whole carrier density distribution of the optical amplifier declines from the input facet to the output facet, and the resulting local saturation photon density is larger than the local photon density of the amplified optical signal, and

wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising:

a slab waveguide region disposed along said gain material;

electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier;

a plurality of off-axis gain-clamping lasers, whose laser mirrors are composed by crystal surfaces, each off-axis gain-clamping laser comprising at least one wing structures, each wing structure having bias electrodes so that the gain coefficient of the wing structure is controlled by the biasing electrodes; and

a wafer base for supporting the respective components,

wherein the cross-cavity gain-clamping lasers are controlled so that the gain coefficient of the wing structures increases from the input facet to the output facet, making the clamped local densities of the gain materials of the optical amplifiers declining toward the output facet.

105. (Previously Presented) The optical amplifier as claimed in Claim 104, wherein the laser mirrors are coated with high reflection materials to enhance the gain clamping efficiency.

106. (Previously Presented) The optical amplifier as claimed in Claim 90, wherein the optical amplifier is a semiconductor optical amplifier, said semiconductor optical amplifier comprising;

a slab waveguide region sandwiching said gain medium;

distributed Bragg reflector (DBR) regions disposed beside the slab waveguide region for acting as mirrors to define off-axis surface emission laser cavities;

a plurality of off-axis gain-clamping lasers, whose laser mirrors are composed by crystal surfaces, each off-axis gain-clamping laser comprising at least one wing structures, each wing structure having bias electrodes so that the gain coefficient of wing structure is controlled by the biasing electrodes;

electronic contacts placed on and under the semiconductor optical amplifier for directing pumping currents into the semiconductor optical amplifier; and

a wafer base for supporting the respective components,

wherein the surface emission lasers defining narrow cavities provide fast response time, and the wing structured off-axis laser cavities control the carrier density distribution of the optical amplifier.

107. (Previously Presented) The optical amplifier as described in Claim 104, further comprising detectors for receiving output optical powers from said gain clamping laser cavities.

108. (Previously Presented) The optical amplifier as described in Claim 107, further comprising semiconductor optical amplifiers for amplifying the optical powers from said gain clamping laser cavities and transmitting the amplified optical powers to said detectors.

109. (Previously Presented) The optical amplifier as described in Claim 107, wherein the photo currents of the detectors are used to control the bias of the wing electrodes and the bias of optical amplifier to adjust the gain coefficient of the optical amplifier.